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ABSTRACT

The main features of courses taught according to the Personalized System of Instruction (PSI) as described by Keller are reviewed, along with the use of repeated testing and undergraduate tutors. The PSI approach is also evaluated in terms of final exam performance, study behavior, and student ratings, based on a study conducted at York University, Ontario, Canada. The PSI courses involve: infrequent lectures and demonstration; an emphasis on written materials divided into units or modules; a clear statement of objectives preceding each unit; mastery of objectives as evidenced in performance on criteria-referenced unit tests that are repeated if necessary; and undergraduate proctors/tutors who administer quizzes and other services. The effect of three methods of evaluating students' term work on their course performance was assessed: (1) repeated testing (i.e., students were given dates for a number of evaluation exercises that they were allowed to repeat 1 week later); (2) no repetition of exercises was permitted but students were given dates for the evaluation exercises and were told that each was an optional exercise; and (3) students were allowed complete freedom to determine the nature and frequency of the evaluation exercises that they would submit. Results were not definitive, but additional research was conducted on the use of undergraduate tutors. Perspectives on the ways in which a course can be individualized and which allows variations in: the content studied, when students will study the material, the behavior of the instructor, and the method of evaluation. Ways that undergraduate assistants can help promote these variations are discussed, and self-pacing and mastery are briefly addressed. (SW)

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PERSONALIZED METHODS OF INSTRUCTION IN UNIVERSITY: SOME INVESTIGATIONS AND COMMENTS

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PERSONALIZED METHODS OF INSTRUCTION IN UNIVERSITY: SOME INVESTIGATIONS AND COMMENTS*

Sheese, R.L.** Personalized Methods of Instruction in University: Some Investigations and Comments, Department of Psychology Reports, York University, Toronto, 1981, No. 107.

The Personalized System of Instruction (PSI) as described by Keller is difficult for an individual instructor to implement. Components of the system can be more easily implemented in isolation. Several examples of such implementations (focusing on repeated testing and undergraduate tutors) are given and evaluated in terms of final exam performance, study behavior, and student ratings. The positive effects of these implementations are described; however, none are found to have the strong effects cited by other researchers for the system as a whole. A suggested categorization of the dimensions to be considered when attempting to personalize instruction is given. A concluding discussion attempts to integrate previous research on the PSI components with the author's personal teaching experience.

I have been teaching university courses for nine years and have always enjoyed experimenting with different procedures that seem likely to benefit my students. Many of these procedures have been stimulated by the Personalized System of Instruction (PSI) first introduced by Keller (1968). Each time I have used a new procedure I have collected evaluation data and I would like to describe what I have learned from my experience with variations of PSI. Let me begin by briefly reviewing the main features of PSI courses. These include:

1. infrequent lectures and demonstrations, given primarily for motivational purposes,

2. emphasis on written materials which are divided into small segments called units or modules,

3. a clear statement of objectives preceding each unit,

4. required mastery of objectives as evidenced in performance on criteria-referenced unit tests which are repeated if necessary,

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5. undergraduate students called "proctors", or "tutors" used to administer quizzes, provide immediate feedback, give tutoring, and often to provide social comfort.

My comments will focus primarily on testing procedures and the use of undergraduates as tutors.

I first became interested in PSI while serving as a graduate teaching assistant at the University of Illinois. With the optimism of youth I then believed that any student who entered the university could master the psychology curriculum if they were provided with the correct environment. The articles I read about PSI seemed to me to describe the perfect educational environment for everyone's needs. Since that time I have followed with interest work which investigates the relationship between person variables and situational factors in instruction. Among others Sullivan (1974) and Allen (1974) have sought to determine which students will profit most from PSI. As a result I now know that the system will work better for some students in some situations, but I began as a believer in its value for everyone. However I was concerned about the complexity of implementing the PSI format in a course. After just a bit of experience trying to begin such a course I realized that very few instructors on their own, would ever be willing to carry out the plan in its entirety. Consequently I began to wonder if one of the components of PSI could be demonstrated to provide most of the benefits of the system as a whole, with the idea that more instructors might be willing to attempt a simpler innovation.

The feature of PSI which I decided to investigate first was repeated testing. I had been teaching statistics courses and it seemed to me that student anxiety was greatly reduced by the knowledge that any particular quiz could be repeated if the results were unsatisfactory. A reduction in anxiety should result in more efficient learning and better performance. Thus I decided that my experimental class would be a conventional lecture/discussion format but with frequent quizzes which could be repeated if the student chose to do so. My interest in interactions between student traits and methods of instruction led me to suspect that the effects of repeated testing might vary according to a student's need for or ability to tolerate structure. For this reason the control groups described in the following study varied in the amount of structure they provided. However, various circumstances made it impossible to collect a measure of the student trait and the hypothesis is not considered below. What follows is a comparison of the effect of three methods of evaluating students' term work on their course performance.

The first method of evaluation was repeated testing in its simplest form, i.e. students were given dates for a number of evaluation exercises which they were allowed to repeat one week later if they desired to do so. One way in which such a system might affect final examination performance is by allowing students to capitalize on the feedback they receive and by encouraging them to review areas of weakness, thus increasing the level of learning during the term. Another possibility is that such a system may remove some of the anxiety inherent in an evaluation system, thus allowing more efficient learning during

the term. Consequently the second method of evaluation was designed to have this property but not the first. Within this system students were given dates for the evaluation exercises and instructed that each was an optional exercise. Students were then evaluated only on those exercises which were completed and submitted. No repetition of exercises was permitted. Another explanation for beneficial effects of these evaluation systems on final examination performance is a motivational one. In some of my previous undergraduate courses utilizing repeated testing many students expressed pleasure with their "freedom" to choose to repeat a test. This same sense of freedom might occur with students allowed to choose to submit or not to submit exercises, and could result in increased motivation to study during the term. Consequently the third evaluation procedure allowed students complete freedom to determine the nature and frequency of the evaluation exercises which they would submit (e.g. five quizzes and a class presentation). Once determined these exercises were due on specific dates with no opportunity for repetition. This procedure was not expected to have the feedback and review effects of the first procedure, however, the possibility of anxiety reducing effects did exist.

METHOD

Subjects

The 232 students enrolled in Psychology 201A in 1974-75 at York University served as subjects in the study. Of these students 189 eventually completed the course. All students were told at the first lecture that an experiment was being conducted in relation to the course and that this involved differences in the nature of their discussion groups. Although all term evaluation was conducted in the discussion groups, students were never told explicitly that the experimental differences involved only evaluation procedures. The number of students dropping the course or switching to another section of the course because of the use of experimental procedures was not determined.

Procedure

The studentswere randomly assigned to one of nine discussion groups. These groups met one hour per week for the twenty-five weeks of the course and were led by one of three graduate assistants (X,Y,Z). Each of the assistants led three groups including one repeated testing (R), one optional testing (O), and one choice testing (C). The specific requirements of these groups are described in the following.

R Groups. These students were required to write eight nine-item multiple-choice quizzes (36% of course grade), three 500- to 1000-word papers (19%) a mid-year examination (20%), and a final examination (25%). The examinations contained both multiple-choice and essay items. Students were allowed to write a second quiz or paper for their discussion group if desired one week after receiving feedback on the first performance. Feedback on all quizzes was immediate, but paper evaluations were given two weeks following submission.

O Groups. These students were required to write a mid-year examination (at least 20% of course grade) and a final examination (at least 25%). Students were also given a list of dates for eight nine-item multiple-choice quizzes (4.5% each) and three 500- to 1000-word papers (6.33% each). These exercises were optional and choosing not to submit one increased the value of the examinations accordingly.

C Groups. These students were required to write a mid-year examination (at least 20% of course grade) and a final examination (at least 25%). Students were also asked to make an appointment with their graduate assistant to discuss additional evaluation exercises which they would like to submit and the value they would have. During the interview specific dates were determined for completion of the assignments. The value of the exercises could be changed before, but not after, their submission.

For all three groups the midterm and final examinations were identical and administered in the same room. These examinations contained objective items chosen from the instructor's manual plus short answer and essay questions. Quizzes were generally similar and occasionally identical for the three groups, but were rarely administered at the same time. The topics for the short papers were identical for all groups.

During the first week of classes students were asked to complete three forms. These were the "Psychological Information Test", the "Attitude toward Psychology Questionnaire", and the "Attitude toward Science Questionnaire", taken from McInish and Coffman (1970). These same forms were also administered during the final examination period. On both occasions students were told that their scores on these forms were not a part of their evaluation system. The six tests will subsequently be referred to as PI1, PI2, AP1, AP2, AS1 and AS2. Also on four occasions (not announced) students were asked to complete a form indicating their study behaviour for the previous week. Some students were asked for their names on the first study probe while others remained anonymous. An example of one form is included on page 7 . In addition to this information the final year high school grade point (GPA) of each student was obtained from the university's admission office. Also during the term students were asked twice to complete forms evaluating various aspects of the course. Students completed both forms anonymously. The only item of information described here which was available for inspection by the course director or graduate assistants prior to the assignment of final course grades was the mid-year course evaluation by students.

RESULTS

Final Examination

A multiple correlation of .54 was found when the final examination scores were regressed on PI1, GPA, AP1, AS1, PI2 - PI1, AP2 - AP1, and AS2 - AS1 for the 104 Ss from whom all scores were available. However, the only significant simple correlations were between the final examination and PI1 (.42), and

between the final examination and GPA (.34). All other simple correlations among these variables were non-significant, including that between PI1 and GPA (.11). Thus these two predictors of final exam score can be considered independent, and the multiple correlation with only these predictors in the regression equation was .52. A 3x3 analysis of covariance was performed on the final examination scores with PI1 and GPA as the covariates. The results indicated no significant differences among methods of evaluation or tutorial leaders - neither was there an interaction effect. These results indicate that knowledge of method of evaluation reduced error variability by approximately 2% while knowledge of tutorial leader allowed no reduction at all. The same pattern of results was obtained in four other analyses of covariance. The dependent variable and covariates for each were as follows:

Dependent Variable	Covariate(s)	Simple Correlation	R
Midterm Examination	PI1	.41	.49
	GPA	.31	
PI2	PI1	.36	.42
	GPA	.24	
AP2	AP1	.41	
AS2	AS1	.38	

In each case there were no significant effects and an approximately 2% reduction in error variability stemming from knowledge of evaluation method.

Course Evaluations

The first course evaluation form was completed by 95 students and a 3x3 analysis of variance was performed on the ratings given to each item. Significant effects due to tutorial leader were found for two items - "tutorial" ($F_{2,84} = 3.25$) and "evaluation procedure" ($F_{2,80} = 4.27$). For the latter item, Group C students gave more positive ratings than did others ($F_{2,80} = 7.33$). This higher rating did not generalize to any other item, nor was the effect found on the end of course evaluation form completed by 119 students. In fact no significant effects at all were found on the final evaluation. Relationships between course evaluation ratings and the variables mentioned above could not be investigated since ratings were collected anonymously.

Study Probe

Similarly results of the four study probes could not be related to the other variables because these were also completed anonymously - after

analysis of the first probe showed considerable differences between those forms with and those without names. No formal statistical analysis of the study probes were completed as the probes were not sufficiently well planned to allow simple statistical procedures, e.g. in many ways the four dates selected for probing were quite incomparable and the number of students present on these occasions varied considerably. Consequently, although averages across the four study probes are given on the example probe together with comments about possible trends over the course, effects of tutorial leader, or method of evaluation; each of these should be taken with caution and require considerably more investigation. The probe on page 7 is exactly as it appeared to students except for the addition of the boxed material which is the results summary. The tutorial leader result for item five does provide some evidence for the validity of the probe since the tutor low on this item was only on campus part-time and therefore rarely available for consultation. Also the Group C result for this item was expected since the nature of their method of evaluation required a good deal of consultation with their tutors about evaluation arrangements. With this in mind some preliminary indications from these probes can be stated. During the weeks probed Group C students spent somewhat more time studying outside of class hours, read more text pages for the first time, and made more frequent use of the published study guides. The results, while forming a consistent pattern in a sense, are very difficult to interpret given the lack of differences on the final examination and the fact that presumably all students had to eventually read all pages of the texts. Were the Group C students reading ahead, catching up for earlier periods of procrastination, spending time on projects which yielded no payoff on the final examination, or merely inflating their reports? The data are insufficient to provide answers. The use of the study probe was a modest attempt to relate instructional variables to some measure of student performance other than final examination scores. It would seem valuable to know more about the effects of various teaching behaviours on the observable behaviour of students and this seems an important area in which instructional research can expand.

DISCUSSION

When I first presented these results (Sheese, 1976) I concluded that repeated testing on its own was not the highly effective procedure I had hoped to find. Harry Murray of the University of Western Ontario suggested at the time that frequency of testing might be a better predictor of final exam performance. Consequently I combined the three groups and correlated the total number of quizzes each student wrote, including rewrites, with his final exam score. The result was a low but significant correlation of 0.14. Despite the statistical significance the definitive proclamation that the more frequently students are tested the more they learn awaits a study better controlled to investigate that issue.

I have considered the possibility that removing the mastery component from the repeated testing was responsible for the lack of a positive effect.

STUDY REPORT

Name of Tutorial Leader _____ Week of December 6-12

Tutorial Time 10:00 12:00

1. Did you attend last Friday's tutorial	(72% yes, decrease over term)	Yes No
2. If yes, did you participate in the discussion?	(60% yes)	Yes No
3. Did you attend the optional class on Wednesday?	(28% yes, leader x lower)	Yes No
4. Not including today did you attend either of the last two lectures? How many?	(1.65)	0 1 2
5. Have to spoken with the lecturer or tutorial leader outside of classtime since last Friday's lecture?	(28% yes, leader z lower Group C higher)	Yes No
6. Since last Friday how many pages have you read in the Hebb text for the first time?	(12. Group C higher)	_____
7. Since last Friday how many pages have you read in the Lefrancois text for the first time?	(11. Group C higher)	_____
8. Have you reviewed in the Hebb text since last Friday?	(55% yes)	
9. Have you reviewed in the Lefrancois text since last Friday.	(52% yes)	Yes No
10. Have you reviewed any of your lecture or tutorial notes since last Friday?	(35% yes, leader Y higher, decrease over term)	Yes No
11. Have you used either study guide since last Friday?	(32% H, 15% L, decrease for L)	Lefrancois ____ Hebb ____ Both ____

12. Estimate the total number of hours which you spent studying for this course outside of class on each day of the past week. Use fractions of an hour where appropriate.

($\bar{x}$ = 4.6, total for week, $S_{\bar{x}}$ = 3.5, decrease over time, Group C higher)

Thursday (yesterday) _____ Wednesday (day before yesterday) _____ Tuesday _____

Monday _____ Last weekend _____ Friday (of last week) _____

When a mastery component is included students are allowed access to positive reinforcement on a regular basis. Within group R described above there were many quiz scores below 60% on the first opportunity yet only 42% of these were repeated on the second opportunity. Thus on 58% of these occasions students denied themselves access to a higher grade. Perhaps if these students had been required to master the material before going on to the next unit, their subsequent final exam scores would have been positively affected. Some previous experience with mastery learning, however, biased me against exploring this possibility.

Although I had not set up a formal study to investigate the mastery component I had taught an elementary statistics course for three years which required a maximum of 80% performance on 12 tests spread over 26 weeks. These tests and the necessary retests were given on specified dates, i.e. the course was not self-paced. In two of these years students were compared to students in five other sections on a common final examination, however no attempt was made to control for student ability; also, the instructor and textbook varied from section to section. There were no significant differences among the mean final exam scores for the six sections. Having gone into both of these exams with great expectations, these results biased me against next investigating mastery as the dominant component of PSI. I will make a few general comments about mastery below, but here I would like to describe some of the reasons I next chose to investigate the use of undergraduate tutors.

A chain of thought began with my observation that there was a difference in the nature of complaints I received from students exposed to frequent testing in the introductory psychology course and those received in the statistics course. There was very little complaining about the testing from statistics students, but often good students in the introductory course were saying something like, "I can't learn anything because I'm always studying for these quizzes." There are many possible reasons for this difference but to me it indicated that what individual students want from a course and a course structure depends on several factors, including the subject matter. Thus, perhaps no one method will allow maximum individualization in all situations. Prior to this I had never thought carefully about what justifies use of the word personalized in PSI. When I began to do so I realized that there are many ways to personalize or individualize a course and they are not all contained in PSI - in fact it would seem that in some situations my students felt that the use of frequent tests ignored their individual needs. I would like to describe briefly my ideas of ways in which a course can be individualized. A similar analysis had been published recently by Davis (1977). As you follow the description keep in mind that I am thinking of the use of undergraduate tutors as a good means to accomplish many of these forms of individualization.

I consider individualized any course arrangement which treats students differently according to individual differences in such things as personality factors, mathematical ability, communication skills, and personal goals

for that class or for the future. I see five ways (somewhat overlapping) in which an arrangement could provide for this individualization.

1. Allow variations in the content studied.

   Is it necessary for all students to use the same text, do the same outside readings, complete the same set of exercises?

2. Allow variations in when students will study the material.

   Various student traits as w[illegible] as outside interests and responsibilities make it unlikel[illegible]at everyone will learn best on the same schedule.

3. Allow variations in your behaviour as an instructor.

   An instructor's preparation and delivery does not have to take the same form for every student. Guidelines and feedback to students can take varied forms depending on the student's behaviour and need not consist solely of the answers to a common multiple-choice quiz.

4. Allow variations in the method of evaluation.

   An instructor can vary the context in which he evaluates, the format of his evaluation items, and the behavior he chooses to observe from one student to another.

5. Allow students a choice in how the above are varied.

Clearly PSI does allow many of these variations. But it seemed to me that there were several ways to make use of undergraduate assistants that would also promote these variations. I have used several different procedures and will describe these briefly before describing the specific situations in which I collected data regarding the value of undergraduate assistants.

One straightforward task that undergraduates can carry out for a course director is to collect recent information, particularly research data, to support the main points or to illustrate the main concepts of a set of lectures. Many lectures simply have too little time to adequately prepare such supplementary material and consequently their students are often forced to abstract a general principle on the basis of few or no concrete examples. While this task is likely to be interesting and useful in developing library skills it does not have the advantage of serving to personalize course instruction.

The past few years my introductory psychology course has been offered with one optional hour per week for seminars and demonstrations on a variety

of topics presented by advanced undergraduates. These undergraduate assistants meet for two hours per week with the graduate assistants and myself to plan the optional sessions a few weeks in advance. Typically the introductory students are allowed to choose from two or more sessions offered in each optional hour. Examples of these sessions include specialized topics such as the contribution of ethology to psychology, and cross-cultural research in perception, participatory experiments in such areas as memory and verbal learning and demonstrations of such things as Piagetian tasks, small group processes, and personality testing procedures. The experiments in particular have been well received and those sessions which have succeeded best have been the ones where considerable instructor supervision was given. However, the amount of supervision time is minimal in comparison to that necessary to provide similar options unassisted. In addition the enthusiasm of the undergraduate assistants would be difficult for the best of instructors to match over an entire year. Also, as pointed out by Linden, et. al. (1977) assistants used in this manner are an excellent foil for the instructor's ideas and can become a major contributor to them.

Wortman and Hillis (1976) report that several institutions have found advanced undergraduates successful as discussion group leaders in the standard format which typically utilizes graduate students. They go on to describe their use of undergraduate assistants to conduct "mini-courses" in an introductory psychology course. The assistants were responsible for selecting appropriate readings, preparing lectures and discussions, and constructing evaluation material for two-week courses on a wide range of topics. The courses were offered to the introductory students as one option for fulfilling a portion of the course requirements and approximately 80% chose to enroll in one or more. Wortman and Hillis indicated that student evaluations of the mini-courses were positive but stressed that care in selection of the assistants and in their supervision were both of great importance.

Rather than involving advanced undergraduates in the formal instructional process, an alternative is to make such assistants available on a regular basis to respond to student questions. For example students could be informed that an assistant would be available in a specific location each day from ten o'clock to three o'clock. My experience indicates that usage of such assistants will be considerably increased if students are expected to turn in written assignments for which the advanced undergraduates are able to provide preparation assistance. My students have seemed much more willing to visit an assistant to obtain help with a specific assignment than to ask their own questions in preparation for an examination.

The typical PSI course utilizes undergraduate assistant for the administration and grading of tests and the keeping of records. The test grading usually includes detailed immediate feedback to students individually about the nature of their errors and opportunity for discussion of these errors. The use of assistants in this manner requires that a large number of test items be available and that the assistants be familiar with all of them. In an elementary statistics course I have been teaching for two years with Paul Herzberg we have not involved the assistants in the

grading process but have encouraged students to review their performance in a general way with the assistants. We have concentrated on motivating students to discuss unit assignments in detail with the assistants before attempting the unit quizzes. This has been done by insuring that the location where quizzes are written is also suitable as a study area with a sufficient number of assistants available to answer questions. Our courses have begun with 135-150 students and 12-15 undergraduate assistants, at least one of whom was available in the quiz room between ten o'clock and four o'clock each day.

I will describe this statistics course in a bit more detail as I have collected some evaluative data regarding the assistants. We found that only by combining the efforts of three faculty members could we manage the workload in setting up a variation on the PSI system. This was not an extra cost to the university, however, as we enrolled three times the usual number of students. Like the usual PSI course the material was divided into several modules which students studied at their own pace and 80% performance was required in each module. Unlike most PSI courses behavioural objectives were not clearly specified although detailed assignments accompanied each module and quizzes essentially tested the same content as the assignments. Lectures were given and considered an important feature of the course. Because of self-pacing, students at any given time were at several different points in the material. Therefore we decided to have the lecturers present their material at different paces, one finishing all the material before the end of the term, another finishing right at the end, and a third who did not finish all material. One advantage of this system was that we could demand extra work at the end of the term in order to each an A+, thus pushing these students a bit closer to their limits than would be the case in the usual course. As described above assistants were available several hours per day to tutor students and to hand out, but not mark, quizzes. The assistants did mark students' assignments although this was for feedback rather than evaluative purposes. The assistants, who had earned high grades in statistics the previous year, were not trained in any form of interaction process. They did attend a two-hour meeting each week with the instructors but this meeting concentrated on insuring that the assistants understood the basic concepts being presented in that week, primarily by reviewing upcoming assignments. They were not paid but rather received university credit for one course in psychology.

I will present data collected by myself and Sandi Wiggins, one of the assistants, in the 1976-77 year in response to several questions that are often asked about undergraduate assistants.

Will such assistants be used by the students? During the last month of the course which was completed by 80 students, 11 hours of observation were conducted in the quiz room. During this time 152 students used the room with a range from 3 to 29 in any one hour period. The highest figure was recorded on the day prior to the final examination. Students could engage in one or more of several activities including quiz writing, studying alone, and seeking assistance. Quizzes were completed by 80 students. Fifty-eight students studied alone for five minutes or longer, forty-six

students sought help from an assistant and thirty-four engaged in miscellaneous activities such as picking up course handouts or reviewing their files to check marks. The average length of an interaction with an assistant was 12.1 minutes with a standard deviation of 10.1 minutes. A total of 98 questions were asked with only 11 pertaining to the quizzes.

What type of questions will students ask? Essentially we wanted to know if students would ask anything other than "Will you show me the way to do this problem?" and whether the untrained assistant would answer in any way other than "You do this." For all interactions where both the question and response could be clearly understood the following categorizations were made.

Questions

Details - The student has completed a portion of the item and is asking about one or more detailed aspects of the item.

Specific - The student is asking about a specific item, but about the major aspects rather than details.

General - The student is asking a general theoretical or conceptual question, e.g., "could you explain Type II errors to me?"

Responses

Direct Answer - The assistant answers the question only.

Indirect Answer - The assistant begins by explaining a related concept and moves toward the original question.

Direct Question - The assistant responds by probing to determine whether student understands the general topic his question involves.

Indirect Question - The assistant responds by probing other less related, but necessary, topics.

The results of these observations are presented in Table 1. There was no evidence of great individual differences among the assistants in the nature of their responses. The most frequent interactions were specific or detail questions about assignments followed by direct answers.

Will the assistants answer questions accurately? I made subjective evaluations of the assistants during nine of the eleven hours of observation mentioned previously. During this time two errors were made by

Table 1

Types of Questions and Responses

	Direct Answer	Indirect Answer	Direct Question	Indirect Question
Quiz, Specific	3	0	0	0
Quiz, Detail	3	1	0	0
Quiz, General	0	0	0	0
Other, Specific	14	10	7	1
Other, Detail	21	5	5	1
Other, General	4	1	1	0

assistants and there were two instances where assistants were unable to answer questions directly related to the course material. Since students could rewrite quizzes in this course the fact that assistants would occasionally make errors was not considered a serious problem. Some general, subjective impressions gained during the nine hours of observation can be listed. Assistants were often slow in their responses to students' questions. This was frequently observed when a student would ask for help in locating an error (his answer did not agree with that in the text) on an assignment item. The assistant and student were likely to work through several aspects of the problem, taking a few incorrect paths, one person being as likely as the other to eventually find the error. In several cases students simply asked an assistant to listen as they worked through a problem. Assistants seemed willing to do this, in contrast to my own tendency to explain everything to the student. There were some instances where a student would ask something like "Have I done this right?" and receive a simple "Yes," from an assistant who probably should have done a bit of probing. The most noticeable difference between the responses of the assistants and the ones which I felt I would have given involved their breadth. In many cases the assistants confined their remarks in a narrow way to the question asked whereas I would have referred to or asked questions about related material in other sections of the course. The eventual value of narrow versus broad responses has not been tested in this context, but it is certainly possible that students perceive the narrow responses as more helpful answers.

How well will the assistants be accepted by the students? Course evaluations were completed by 70% of the students who finished the course and the responses to several items are given in Table 2. In general the students have responded favourably to the assistants. Although no direct comparison is made among the various course elements, in item A.3 it appears that students are more agreed about the benefits of the assistants than about other elements. Items 7 and 9-16 indicate that the students saw the assistants as knowledgeable and conscientious. Unfortunately comparison opinions with respect to faculty members were not obtained for items 14 and 15. If large numbers of students are embarrassed or hesitant to approach faculty members undergraduate assistants could be valuable on this basis alone.

Will the assistants view their experience as profitable? Eleven of the assistants completed evaluations at the end of the course and their responses indicated a strong feeling of profiting from the experience. The assistants generally felt competent to deal with the material and when they did have difficulties with a concept it was more often due to oversimplification than to misunderstanding. They also felt that they received insufficient feedback from me on their performance. I had originally hesitated to observe them for evaluative purposes feeling they would be too intimidated, but I now believe that in fact they welcome such observation.

One should keep in mind that the above information was obtained from a statistics course and somewhat different procedures and results might be relevant in other types of courses. For example, assistants in this course seemed to indicate that they benefitted greatly from elaborating the oversimplifications they had formed in their first statistics course. In

Table 2

Summary of Course Evaluation Responses

A. 3. Please rate the following aspects of the course for the degree of benefit you felt they provided towards understanding the course material. Use the following codes: A - very beneficial, B - beneficial, C - neutral, D - not very helpful, E - useless.

a. Lectures A - 11 B - 28 C - 9 D - 5 E - 5

b. Assignments A - 31 B - 22 C - 3 D - 1 E - 1

c. Quizzes A - 21 B - 31 C - 5 D - 2 E - [illegible]

d. Teaching Assts. A - 31 B - 17 C - 8 D - 1 E - 0

e. Text 1 A - 24 B - 31 C - 4 D - 0 E - 0

f. Text 2 A - 6 B - 22 C - 21 D - 6 E - 4

g. Text 3 A - 1 B - 4 C - 17 D - 21 E - 15

7. How often did you ask for help from teaching assistants?

never - 1 very infrequently - 10 occasionally, but less than once a week - 11 once a week - 26 several times a week - 13

9. I _____ felt that the teaching assistants were able to provide the information I wanted.

21	23	15	0	0
nearly always	often	sometimes	rarely	never

10. I _____ found that the teaching assistants had sufficient understanding of the course material.

26	18	14	0	0
nearly always	often	sometimes	rarely	never

11. In comparison to faculty members you have known would you say the teaching assistants generally took your questions _____ seriously?

3	23	31	1	0
much more	more	about the same as	less	much less

12. In comparison to faculty members you have known would you say the teaching assistants generally gave you _____ detailed answers?

5	24	19	8	0
much more	more	about the same as	less	much less

13. In comparison to faculty members you have know would you say that teaching assistants generally understood your question? _____

2	10	33	10	1
much more	more	about the same as	less	much less

14. I _____ felt that the teaching assistants were being condescending in dealing with my question.

-	1	7	14	31
nearly always	often	sometimes	rarely	never

15. I _____ felt embarrassed to approach the teaching assistants.

-	1	5	12	38
nearly always	often	sometimes	rarely	never

16. Have you had any negative experiences in your interactions with the teaching assistants?

9	Yes	47	No	Neutral - 1

Describe if you wish (names not required):

Most of the comments here were complaints that near the end of the course several assistants fell behind in preparation of the assignments and thus were not always able to answer questions. The few other comments mentioned incidents involving a condescending attitude by a T.A.

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comparison several fourth-year level assistants in my introductory course have commented that they greatly valued the opportunity to coordinate all the separate pieces of information they had obtained in various specialized psychology courses.

Do the assistants improve students' learning? I can not speculate on this matter as no control class was available. Robin (1976) reviews 14 studies dealing with the use of undergraduate assistants; however, most of these simply describe a method of using assistants, or compare various methods of using assistants without considering a no-assistance control group. Related to method of assisting there is some evidence that students of assistants working for a second year perform better than students of first-time assistants. The three studies which deal properly with the effect of assistants provide conflicting answers to the question of improved learning.

Whether or not the students benefitted, my assistants certainly felt that tutoring was an excellent method for promoting their own learning. They have been virtually unanimous in citing it as their most profitable university learning experience. This conforms with the intuition of many teachers who have expressed the feeling that they only began to understand a subject well when they started teaching it. Consequently I began to consider methods by which I might demonstrate the value of teaching as a learning technique and I note that Johnson, et. al. (1976) have recently provided some such evidence. My investigation began in an educational psychology course where I paired students prior to each quiz and asked one of each pair to prepare a segment of the course material and tutor his partner on this material. Schermerhorn, et al (1974) have reported on a similar procedure which they call the learning cell, however, as with other studies they make no comparisons to a no-assistance control group. I can claim only limited success for my technique as there were no effects on quiz scores, though evaluations of the procedure were very positive. (For a detailed account see Sheese, 1978.) Like much instructional research in the classroom setting there are a multitude of extraneous variables in this situation which are difficult to control. For this reason I believe that future work on this question could be done more profitably in a laboratory setting. I intend to bring in students who will read unfamiliar material, tutor others and be tested. Their performance can be compared to others who only read or who prepare to tutor but do not actually do so.

Before concluding I would like to make a few brief comments about various components of PSI which I have not researched in a formal manner.

Self-pacing. Problems with procrastination and withdrawals are frequently reported for courses with the self-pacing feature and the statistics course I have been describing was no exception. In 1976-77 we had a 45% withdrawal rate and 12 weeks into the 26-week course over 10% of the students still had not written the third of seventeen quizzes. Henneberry (1976) has shown that initial progress in writing quizzes is a good predictor of final course performance. He has suggested the use of deadlines for some initial "priming" period, while Miller et al. (1974) have suggested that the

instructor set target dates for the start and completion of all quizzes. Such a procedure of course reduces self-pacing to the short interval between the starting and completion dates. In our 1977-78 course Paul Herzberg attempted to deal with these problems by setting deadlines for the first five quizzes and by personally contacting students who were working at a slow pace. He also felt many students procrastinated out of fear that the quizzes were very difficult and from misunderstanding our instructions about how PSI worked. Consequently the first unit of the course was a lengthy description of the course procedures, the first assignment was to attend a meeting with an assistant in the quiz room to discuss the procedures, and the first quiz was an easy one covering only the course procedures. In this course the withdrawal rate was 25%, and 12 weeks in to the year everyone had completed the first four quizzes. Of course, there are other variables which could account for these differences; furthermore, no one has presented any evidence that students who are forced to work faster than they would have under other conditions learn any more or perform better as a result. Those students who would have dropped out now earn a course credit but they may be the ones getting low grades and little knowledge. Whether or not this is a benefit is unclear.

Mastery. One aspect of mastery that has been investigated often is the level of mastery required. For example Davis (1973) compared students under a 50% criterion with others under a 100% criterion. Whitehurst and Whitehurst (1973) used a 100% criterion in each of two classes but in one the only possible grades were A or F. The usual range of grades was possible in the other depending on the number of units successfully completed. They report that the percentage of A's was 17% higher in the first group; however, there was no difference between the two sections in a pre-post measure of course knowledge. This suggests to me that students forced to perform at a higher level than they really wish to perform will use non-productive methods to do so. Cheating, of course, is one possibility, but even when this is made impossible I have the feeling that a high criterion will encourage rote memorization and other inappropriate strategies to the detriment of attempts to understand. I have been surprised to find just how naive I was in this regard, having once assumed that given the chance everyone would eagerly attempt to master the material completely. I now believe that an important part of individualizing a course is recognizing that students have a variety of reasons for taking a course and different ambitions regarding their level of understanding. I believe that one can push people who have little desire to understand material a bit, but not far. In this case it may be that more will be gained by attempting to attract their interest. In my own courses I have had trouble with an 80% mastery criterion. In my first few years I found it very tempting to give students who had rewritten quizzes a few times the benefit of the doubt when marking borderline answers. Lately I have managed to overcome this a bit and students are doing more rewrites, but if one writes three or four quizzes from a pool of fairly similar items it seems likely that the quiz is as much a measure of perseverance as of learning. Some research with a large pool of dissimilar, objectively scorable items would be useful in determining the effects of various mastery levels.

One of the major disappointments I have had in teaching was when I discovered that using a high mastery level during the term would not insure similar high performance on a final examination. I have already mentioned my students' performance on a common final exam in a few of the first statistics courses. Since then I have discovered several reports of high term-mastery levels with much lower mean performance on a final exam (Mallott & Svinicki, 1969; Quigley, 1973; Morris and Kimbrall, 1977). I say this is disappointing because I saw mastery as a procedure which would bring all students to the same level of knowledge. Lower final exam means alone do not rule out the possibility all students are operating at the same level; it might still be the case that there was little variability in final exam scores. Also evidence that the course procedures had differentially assisted weak students would be reflected in a low correlation between final exam scores and grade point average and/or ACT scores. However, studies do not report the variability of final exam scores and the correlations referred to are always greater than zero where reported. In the PSI-type statistics course I have just finished the GPA-final exam correlation was .38 which is a bit lower than others have reported. My final exam like those reported in this literature was designed to test "generalized concepts" and integration, though unit quizzes had not done so consistently. From this I would conclude that, of their own accord, "good" students work on this higher cognitive level while weak ones do not. Thus students perform similarly during the term but the "good" ones still excel on the final exam. This suggests that unit quizzes should be revised and/or review units should be frequently spaced throughout the material. These units should be written with generalization and integration as specific objectives. This must be tried before any conclusion can be reached regarding the suitability of mastery, and PSI in general, for achieving higher level cognitive objectives.

Behavioural Objectives. I have never attempted to formalize my course objectives. I mentioned before that I believe the course assignments do this to some extent, certainly material I present in lecture is more likely to be considered by students if I refer to it on their assignments. Primarily, I feel students use their past quizzes to determine what they will study. They seem very good at analyzing them to determine what types of material are likely to appear on subsequent quizzes and these become the implicit course objectives. I have had discussions with several students about instructors who constantly tell their classes to study basic concepts, yet persist in constructing tests of the specific details from which those concepts derive. Given this I would suggest that if one does specify his objectives he should be sure to test them as well or they will soon cease to be the objectives of most students.

In conclusion I must say that my work to date has not led me to a single instructional feature which carries a strong effect when used alone. With respect to PSI Calhoun (1976) has suggested that the system works best when all of the elements are combined. As mentioned above, I would regard this as an unfortunate conclusion given the great difficulty involved in first arranging a PSI course. In any event, I still believe that there is value in attempting to determine as precisely as possible the effects of the various components of PSI. Indeed I would urge instructors to evaluate the effects of their procedures, innovative or not, whenever possible. In my own future I am uncertain what format my next courses will take, but fortunately I have a sabbatical year to consider that.

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